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THE MOONLIGHT HEAD ROCKSHELTER

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Abstract: An aboriginal midden located at the base of sandstone and shale cliffs near Cape Otway, southwestern Victoria, was excavated in 1980. It contained evidence of occupation of the coast for approximately 1000 years prior to the contact period. The midden deposit consisted mainly of the remains of shellfish, but also contained animal bones and stone artefacts. Analysis of the shellfish revealed a shift in exploitation from the larger species, which are more difficult to harvest, to use of the smaller though more easily gathered animals. Study of the number of animals represented by the vertebrate remains, and calculation of the density of material, indicates that this shift is associated with increased exploitation of the land fauna in later periods of occupation. Finally it is suggested that this is indicative of a change in the logistical pattern of land use in the Otway region.

Moonlight Head Rockshelter was excavated in January and February 1980, in what was envisaged as one of the first steps in a broader study of the Gellibrand River region, aimed at studying coastal and estuarine exploitation strategies, and inland settlement patterns.

THE SITE AND ITS SETTING

Moonlight Head Rockshelter
Victoria Archaeological Survey Site Number 75203/029
County of Polworth, Parish of Wangarrip
Latitude 38°45′ 5″ S; Longitude 143°13′ 15″ E

Moonlight Head is one of a number of cliffed promontories which jut out into the sea near the western edge of the Otway Ranges (Figs 1, 2). A few kilometres to the west the cliffs end at the mouth of the Gellibrand River, which forms a large estuarine basin behind the tidal sand-bar dividing it from the sea. Similar estuaries are seen elsewhere in the Otways, as at Glen Aire and Apollo Bay.

The Otway Region can be divided into two basic landforms: 1, the Coastal Plains and 2, the Otway Ranges which rise to a maximum height of 670 m. Moonlight Head lies approximately on the western division between these areas (Douglas 1977: 19). Behind the site the ranges rise to approximately 200 m at 2.5 km inland, falling again to the Gellibrand River some 4.5 km inland.

Annual rainfall ranges from 900 mm on the coast to 1800 mm inland. There is some seasonal fluctuation with most rain falling between May and October (Linforth 1977: 61). The mean summer temperature on the coast is about 20°C, and about 13°C in winter (Victoria Land Conservation Council 1976: 32).

Although a considerable proportion of the land has been cleared and used for agriculture—predominantly dairy farming and grazing (V.L.C.C. 1976: 225)—large tracts of land have remained in public ownership. On much of this land, traces of the native vegetation remain.

The Coastal Vegetation Complex generally extends inland for about 1 km or less. The exposed frontal dunes now support a grassland of marram grass, tea-tree scrub (*Leptospermum laevigatum*) and sallow wattle (*Acacia longifolia*). This complex gives way to various types of Open Forest (V.L.C.C. 1976: table 7), principally of brown stringybark (*Eucalyptus baxteri*) and messmate (*E. obliqua*). Further into the ranges, as the rainfall increases, mountain ash (*E. regnans*) and blue gum (*E. globulus*) come to predominate, and the undergrowth becomes more dense. In some of the wettest gullies a Closed Forest has developed.

The shore near Moonlight Head is rugged and difficult of access. Behind the sandstone and mudstone cliffs (Douglas 1977: 19), which drop sharply to the sea, are a series of steep rounded hills. Small isolated beaches and rock platforms lie at the base of the cliffs, and are covered by the sea at high tide. Waves rolling against the cliff face have sculptured numerous sea caves.

Coastal archaeological sites—middens and lithic scatters—are normally found on high dunes or cliff tops as, for example, further east at Seal Point near Cape Otway (Lourandos 1980, Bowdler & Lourandos 1982), and at Glen Aire (Stuart 1979). Moonlight Head Rockshelter, however, is unusual in this respect, tucked into the foot of a cliff in a sea-eroded cave, and therefore directly adjacent to the beaches and rock platforms. Sea caves of this kind are daily scoured by tidal waters; indeed, exceptionally high and storm-aggravated tides are active agents in the contemporary destruction of the midden located in Moonlight Head Rockshelter. Alec Neave, who has known the site for over 40 years, can clearly recall when the midden extended perhaps as much as 10 m further to the south. What is left today is only a small part of a once very substantial deposit.

When we first saw the site in 1979 a nearly vertical face of stratified midden deposit over 1.5 m in depth and about 2 m in width was visible near the northwest cliff-wall. On the east, thick, heavy, deposits of sandstone boulders and soil covered further deposits. The more visible western part was also sealed by a massive roof-fall of extremely large sandstone blocks. Other similar blocks lay on the pebble-strewn slope running down from the midden to the sea.

Moonlight Head Rockshelter is not a very effective shelter, because the prevailing winds from the west or southwest blow rain or spray directly into the site, while a constant trickle of sandstone fritters off the high walls.

Water, however, is available from a small perennial creek running over a waterfall and into a catchment on higher ground behind the shelter. This is reached by climbing up and over the high steeply sloping roof-fall currently covering the midden deposit, moving around the eastern curve of the cliff-wall at the rear, and thence over a narrow shoulder of fairly recent slumped soil onto a small flat open space high above the sea. This spot is better protected from the wind and, unlike the midden area, is warmed by the sun. A small test excavation (MLH II) was carried out here (see below).

At present it is possible, although not without some difficulty, to climb a 3 m high face onto the top of the waterfall, and then follow the creek inland up a narrow valley, through thick scrub, or climb a steep slope to the top of the cliff. The site may also be approached from the west, by climbing down a cliff onto an adjacent rock platform. A somewhat safer way to the site is from the east along the rock platforms and beaches after descending a less formidable section of cliff below a steep hillslope. This route, and the western cliff, are nearly impassable when the water is up, and extremely dangerous in a storm. Access to the site, then, is more or less limited to fine weather.

Two main rock platforms lie beside the site. At high tide, or during windy weather, the rock platforms are under water. When the water is low, large flat areas are exposed, with sharp edges dropping off into deep water. Except on rare calm days the water is rough, and diving off these platforms would always have been hazardous.

In summary, the site is the remnant of a once-extensive, apparently well-stratified and deep midden, located in a high-walled sea-washed shelter formed at the base of cliffs, beside broad rock platforms and a reliable source of water.

AIMS OF THE EXCAVATIONS

Specific Research

The more specific aspects of our research aims were closely related to earlier research by one of us on coastal exploitation patterns and adaptations (Vanderwal 1978, Vanderwal & Horton 1983). The Moonlight Head excavations also fitted into the development of knowledge of and research into the coastal archaeology of Victoria (Coutts 1981a, Coutts *et al.* 1976). This, combined with research on coastal sites elsewhere in Australia (e.g. see articles in Bowdler 1982), provides the possibility of assessing variations in the exploitation of coastal resources in different localities and situations. In this context the relatively unusual setting of Moonlight Head Rockshelter, its apparent depth, and its integrity as a closely defined stratified site, were seen to be of particular interest and value.

Salvage

As shown by the work of the Victoria Archaeological Survey, coastal middens are constantly being threatened by both natural and human activities (Coutts *et al.* 1976). They are certainly the most obviously threatened sites. This site was being eroded, and would not have survived in any reasonable form for very much longer.

Teaching

The project was envisaged as providing an opportunity for fieldwork for students. A further consideration was the acquisition of data which senior students could use as the basis for their own research projects. These aspects were all developed in the field, in laboratory sessions, and in the preparation of the final report.

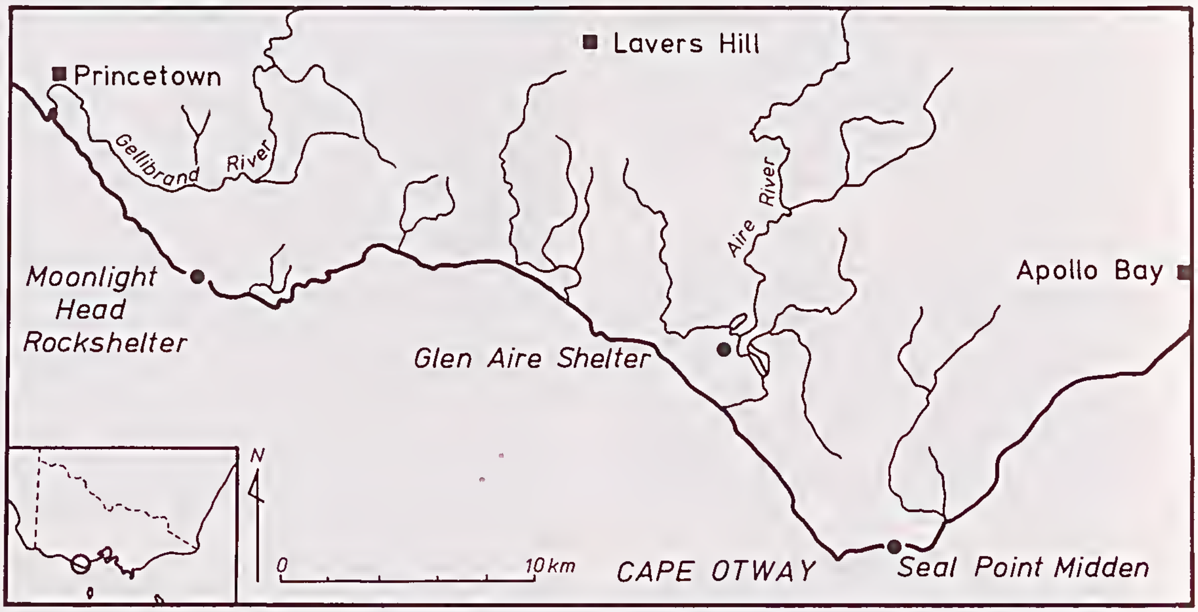

Fig. 1—Map showing localities mentioned in text.

Fig. 2—Coastal environment of the Moonlight Head Rockshelter. The site is in the middle distance.

Regional Research

At a more general level the Moonlight Head excavations were envisaged as providing a starting point for future research in the general area of the Gellibrand River. This study, now being carried out by one of us (DZ), will ultimately place this site in a regional context.

THE EXCAVATIONS

METHODS

General

The nature and location of the site posed some particular and unusual logistical problems. Access to the rockshelter, as already indicated, was difficult—but in addition the archaeological deposits were covered by massive blocks of sandstone. Extremely poor weather conditions added to an already arduous field situation: during the six weeks at the site there were not more than three days when it did not rain. Although it was midsummer, it was windy and bitterly cold. Storms and the resulting high seas made access along the beaches (otherwise relatively easy) at first difficult, later dangerous, and finally impossible. The alternative route was hardly less hazardous. Equipment and finds had to be carried to and from the site over rough, steep terrain.

Organisation

The site was laid out in a metric grid, aligned with the nearby cliff wall, in order to take maximum advantage of the space cleared by the initial removal of overburden (see Figure 3 for the layout of the grid). For convenience of description a conventional 'north' is defined. This is in fact more correctly northeast. In discussion of the excavation units, however, this conventional 'north' is used unless otherwise indicated.

Units. Within this grid, six Units, of different size, were excavated and materials from within each were kept together. Their size was dictated partly by the nature of the site, and partly by considerations of time. Two units were 1 m^2, three were 0.5 m^2, and one was 0.25 m^2, making a total area excavated of 3.75 m^2. These units were excavated independently, marking the relevant points on adjacent units to facilitate correlations.

Removal Numbers. Within each unit excavation proceeded by defined Removals. This neutral term covers any defined deposit—an arbitrary split, a stratigraphic layer or lens, or a feature (such as a hearth). An attempt was made, where at all feasible, to excavate by stratigraphic deposits, although the complex nature of the interleaved and minor mixed lenses of midden material made this difficult in practice. Some clearer lenses and layers, especially of sand or roof-fall, could, however, be traced across from one Unit to another.

Levels. Levels accurate to the nearest centimetre measured from a fixed datum were taken at the corners, centres of each side, and centre of the Unit after each Removal.

Sections. Before excavating the initially clear face of the midden, and after completion of each Unit, or set of Units, sections were drawn showing the major stratigraphic features and spot-heights of relevant removals. The final drawing of the north and east sections of Unit 106 (the clearest and deepest section) could not be completed as the wall collapsed under a massive rock fall.

Recording. Standard procedures were followed, recording the nature of each Removal, including Munsell colours (duplicate readings), and pH values for all Removals in Unit 41. About 90 minutes of Super-8 movie film were shot, to provide a more dynamic record

Fig. 4—Stratigraphic sections, Moonlight Head Rockshelter.

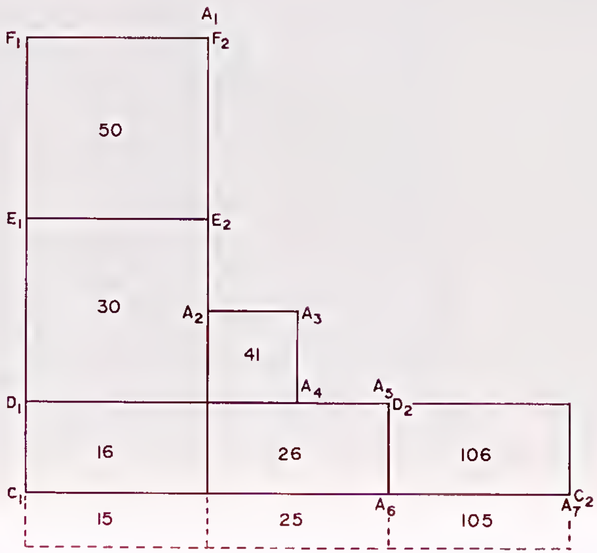

Fig. 3—Plan of excavation at the Moonlight Head Rockshelter. Subscripted letters refer to stratigraphic section drawings (Figs 4, 5). Orientation is conventional north.

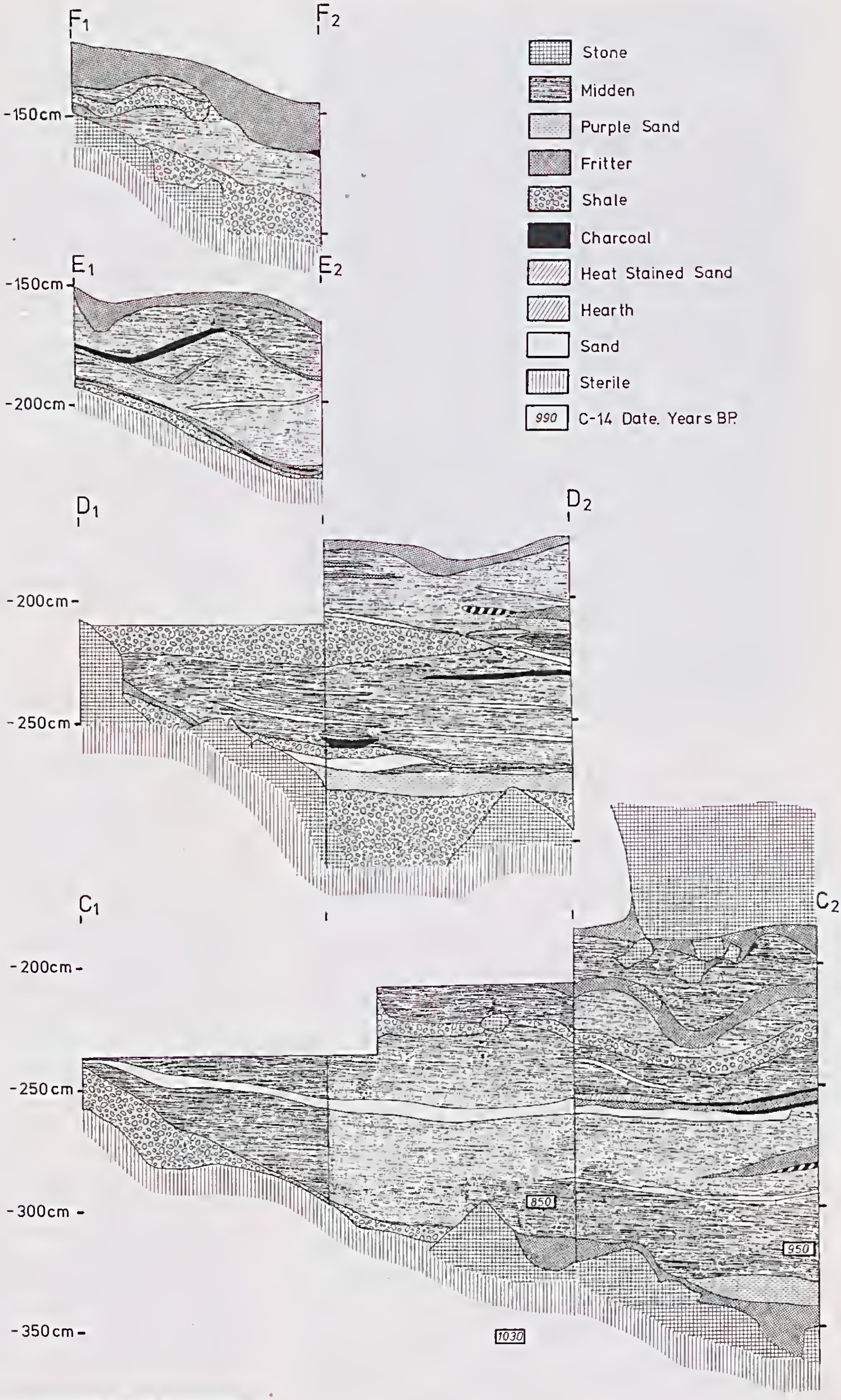

Fig. 5—Stratigraphic sections, Moonlight Head Rockshelter.

Fig. 6—Stratigraphic section of Unit 106, Moonlight Head Rockshelter.

of the excavations, with potential for producing a film on excavation methods.

Collection and Sieving. All deposits excavated were processed in nested sieves of 12, 6 and 3 mm (phi = −6.2, −3.2 and −1.2). Stone artefacts and bones were separated and marked individually with Unit and Removal numbers. All shells were sorted by species, counted, and weighed to the nearest gram. Shells from most units were discarded after processing, although all those from Unit 106 were retained for more detailed analysis. Samples of soil, and of carbon for dating, were taken as required. All sieve residues and other material from Unit 106 were retained, and are available for further analysis.

Process of Excavation

The heavy blocks on top of the deposits were broken up by hammer and chisel, and levered or winched away. Some 5 tonnes of rock were removed in this way, exposing a khaki sandstone grit layer which may have weathered off the roof immediately prior to the massive roof-fall, or off the fallen blocks themselves.

We were then able to take advantage of the vertical (SW) face of the site to work into it from the side—that is, to see layering in section and then attempt to trace these often fugitive lenses in plan as each was removed. The same process of working on units after examination of both exposed horizontal and visible vertical aspects was applied in all cases.

The originally exposed face of the site (running across the centre of grid squares 1, 2 and 10) sloped outward toward its base. After preliminary cleaning, excavation began in Units 16 and 26 (the northern halves of squares 1 and 2). The shape of the eroded face of these units limited excavation to the lower sections: the upper deposits, seen in sections, were not excavated in the squares themselves. This exposed the vertical face of squares 3 and 4; square 3 was excavated as a square metre Unit (Unit 30). The next square to the North, 5, was then excavated, again as a full square metre (Unit 50). These two Units were relatively shallow, with the midden deposits thinning out as the underlying rock sloped up towards the back of the shelter.

Pressure of time, and of overburden, restricted excavation in square 4 to a quarter (Unit 41). The final Unit excavated was the 0.5 square metre Unit 106. A massive block of sandstone on top of this Unit could not be removed without destroying the midden deposits, but the depth of this part of the site made its excavation desirable. This was only just achieved before the wall collapsed under the weight of the blocks.

STRATIGRAPHIC ANALYSIS

Structure of the Site

As seen in the sections (Figs 4, 5, 6) deposits (especially to the north) tend to be horizontal, although bedrock (or sterile basal fall-and-fritter deposits) drops steeply away from the north to the south and from the west to the east.

The surface of the midden, below the major rock fall, tends to reflect the lie of the bedrock in the north-west while levelling off in the southern and eastern Units. The deposits are therefore shallower to the 'north' and 'west'. In some areas the horizontal bedding is disturbed—particularly in the 'south-eastern' Units (41, 106) where the massive impact of the final rock fall is clearly evident in the sections. Here the force and weight of the roof-fall has compressed deposits, and depressed parts of some layers by at least 20 cm.

Archaeological Deposits

Several categories of deposit, for the most part horizontally bedded, may be defined.

Sandstone or shale roof-fall

a, heavy blocks (as on the surface of the site) or smaller chunks of rock represent major, or less dramatic, episodes of collapse from the cliff-wall or vault. b, khaki-brown grit or finer material, part of the constant frittering off the cliff, dusting the site, forming distinct deposits between episodes of midden formation.

Mixed midden lenses

Typical midden deposits form a complex interleaving of shell, burnt or heat-stained grit fritter, and charcoal mixed in with the sandstone grit matrix. For the most

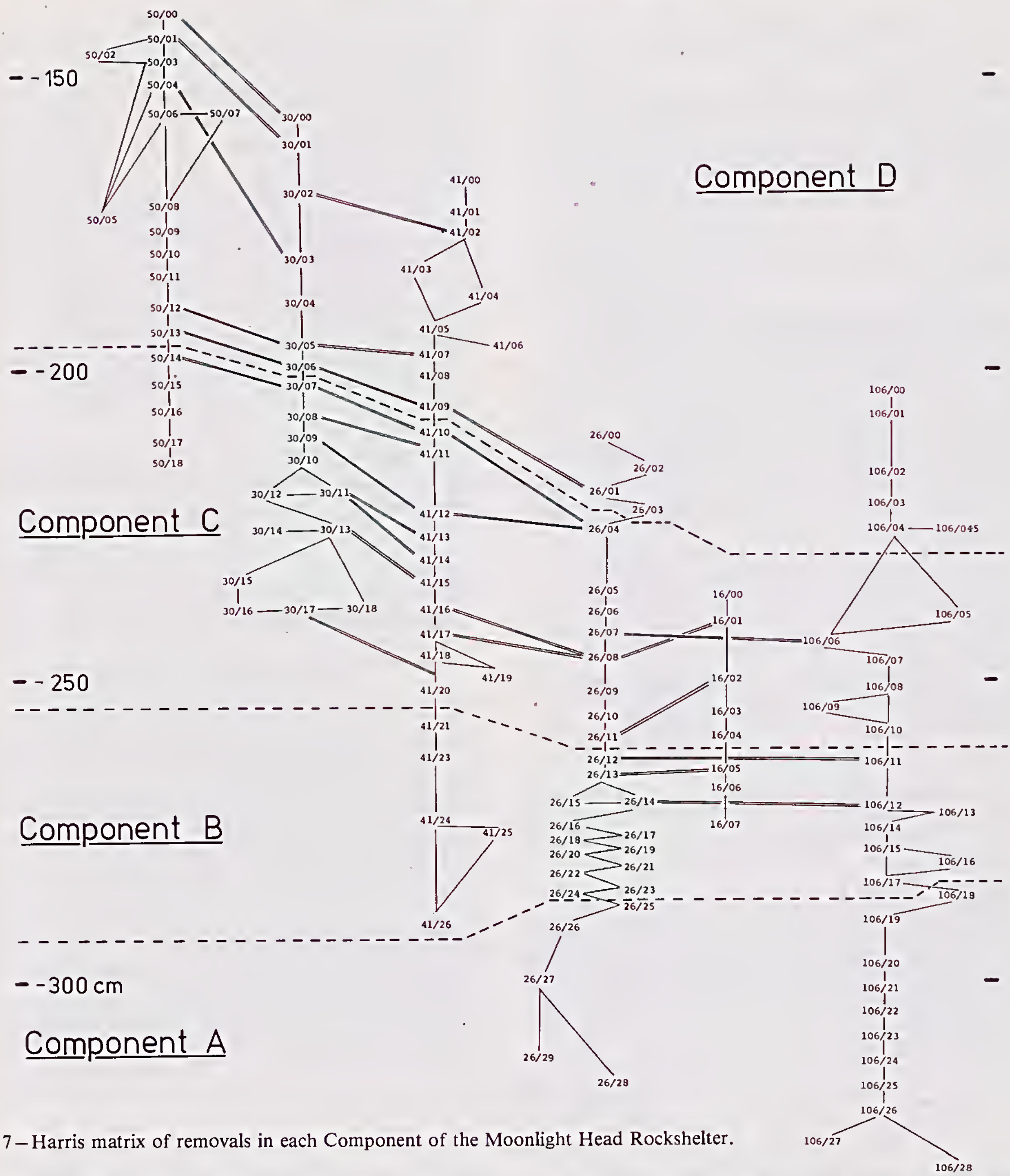

Fig. 7—Harris matrix of removals in each Component of the Moonlight Head Rockshelter.

part individual lenses could not be traced over more than small areas, often less than the area of any Unit.

Quartz sand

These sandy deposits, consisting of layered or lensed quartz beach sand, in some cases stained to a purple colour by fire, could have been brought to the site in a number of ways: a, carried in by people; b, blown in from sea-laid sand deposits in front of the site; c, washed in by exceptionally high tides; d, washed in from above.

In only one place do sandy deposits have any clear suggestion of having been water-laid, and even there the slight wave pattern could equally well have been caused by human or other natural factors. Wind, with some human transport into the site, would seem to be the most reasonable explanation for deposits, especially in the upper levels. Small rounded quartz grains were probably either washed in from above or derive from inclusions in the sandstone cliffs. The presence of a few patches of water-laid well-sorted clayey sediments also suggests water washing in from above. At the time that

TABLE 1
A, REMOVALS IN EACH COMPONENT

COMPONENT	Unit 50	30	16	41	26	106
D	0-13	0-6		0-9	0-3	0-4
C	14-18	7-18	0-4	10-20	4-11	5-10
B			5-7	21-26	12-24	11-17
A					25-29	18-28

B, VOLUMES OF EACH COMPONENT IN EACH UNIT—CUBIC METRES

	Unit 50	30	16	41	26	106	Total
D	0.32	0.29		0.08	0.05	0.11	0.85
C	0.23	0.30	0.09	0.11	0.14	0.11	0.98
B			0.08	0.07	0.12	0.15	0.42
A					0.16	0.19	0.35
Total	0.55	0.59	0.17	0.26	0.47	0.56	2.6

the shelter was occupied the rock and soil cover in the upper areas of the site would not have been present to prevent water from trickling into the shelter.

Charcoal

Some specific lenses of charcoal, as distinct from charcoal-rich midden deposits, could be defined. In some cases these underlie, or are associated with, 'hearth' features.

'Hearths'

These are interpreted from hard-packed circular orange (heat stained) gritty deposits, 1-3 cm thick in the centre and about 40 cm in diameter and generally associated with evidence of burning (heat-stained sand and charcoal).

MAJOR STRATIGRAPHIC COMPONENTS

The section drawings show the main stratigraphic features in the site, and the Harris Matrix demonstrates relationships between specific Removals (Figs 4, 5, 7).

Within each Unit the stratigraphic relationships are clear and straightforward. In considering the site as a whole, the complex layering of Removals, their unequal volumes and uneven surfaces make simple correlations between Units difficult. Some clear equivalences and easily recognised stratigraphic horizons can, however, be defined and traced across the site. These, together with equivalences between Removals in adjacent Units observed during excavation, make it possible to divide the site into 4 main stratigraphic Components.

Component A is found only in the deepest (southern) area of the site (Units 16, 106) and can be separated from later Removals by a distinct layer of quartz sand.

Component B above Component A, has as its upper limit a sandy and shale-and-sand layer that can be seen in section running (east-west) across Units 26, 41 and 106, again confirmed by correlations noted in the field.

Component C lies below a clear, well defined wedge of shale representing a fairly large fall from the western cliff wall.

Component D consists of the upper deposits in all units except 16.

The Removal numbers in each Component and their volumes are shown in Tables 1a and 1b.

While within each Unit the individual Removals are the minimum archaeologically defined units which may be used in relative sequence, these 4 main stratigraphic Components serve to link deposits from different Units and provide the possibility of broader-scale comparisons, and in that context form the 'finest reliable level of resolution' (Stern 1980: 76).

The volume of material in each Component, for each Unit, varies (Table 1b). In order to make valid comparisons appropriate compensation must be made. These are discussed in detail below.

The lower two Components (A and B) appeared during excavation to have a higher proportion of grit matrix to shell than other deposits. This cannot be due to

TABLE 2
MOONLIGHT HEAD RADIOCARBON DATES

Laboratory Code No.	Unit/removal	Date BP	Nature of Removal	Absolute level	Approx. cm below surface
GaK-9007	50/2	180±90	burnt midden and charcoal concentration	146	6
GaK-9008	106/10	590±110	dense charcoal in midden below hearth	261	41
GaK-9010	26/28	850±110	mixed midden and roof fritter	298	87
Beta-1690	106/23	950±65	midden and charcoal concentration	315	103
GaK-9009	41/13	1020±110	midden lenses	231	51
GaK-9010	22/0	1030±120	hearth	355	147

Fig. 8—Radiocarbon dated (C14) ranges of absolute levels (depth below datum) at the Moonlight Head Rockshelter.

differential preservation resulting from chemical decomposition, as all pH values recorded were the same (8 and 9). It must rather be related to a different depositional situation accentuated by the extremely irregular rocky basal surface.

Reworking

Some questions have been raised at other Australian coastal sites about the possibilities of the reworking of deposits by the sea, while other disturbances of earlier deposits by subsequent occupation is a universal problem in archaeological sites. The features characteristic of reworked middens (Hughes & Sullivan 1974) cannot be demonstrated at the site and there is no reason to assume any significant disturbance by either natural or cultural agencies at Moonlight Head Rockshelter. Several additional factors which support this view of an absence of reworking by waves and the stratigraphic integrity of the site are: a, the presence of hearths throughout the deposits, from the earliest occupation; b, the horizontal bedding of features such as hearths; c, the abundance of charcoal, in the midden generally, and in association with hearths; d, no evidence of scouring by wave action; e, the violence of wave action on this high energy rocky coast would cause the removal of deposits at the front of the site rather than minor displacement; and f, additional support for the internal integrity of the stratigraphically defined Components was found during the analysis of the stone artefacts, as it proved possible

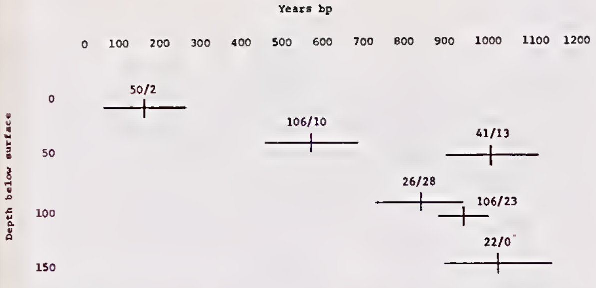

Fig. 9—Radiocarbon dated (C14) ranges of depth below surface at the Moonlight Head Rockshelter.

to refit some flint pieces from vertically non-adjacent Removals, but not between Components.

Dating

Six radiocarbon dates were obtained for deposits in the site (see Table 2). In all cases charcoal samples were collected with tweezers directly into aluminium foil. Sample GAK-9010 was collected from a hearth located during cleaning and preparation of the section, prior to the main excavation.

Dates are determined using the Libby half-life of 5568 (5570) years. Ranges are indicated at one standard deviation.

Five of these dates show a regular pattern of increasing age with depth (Figs 8, 9). Although direct correlation of depth (that is absolute depth) and age of deposits cannot be assumed with any midden site, particularly where the underlying basal material is as uneven as is the case at Moonlight Head, the consistent relationship observed here would seem to indicate a relatively even rate of accumulation of deposits in the site. Moreover the pattern could be taken to confirm our views on the integrity of the site, and the lack of significant reworking of the deposits by natural (or cultural) agencies.

The sixth date (Unit 41/13) is anomalous. In terms of absolute levels—height above bedrock or below the surface, or, more importantly, by natural stratigraphy—it is not possible to explain away this early date while the other 5 samples conform to a clear and predictable pattern. No other relevant carbon samples are available from Unit 41 to allow a check on contamination or other sources of error.

If we use only the five consistent dates, we may estimate the approximate ages of the four Components of the midden.

Component A—1000 BP to 800 BP
Component B—800 BP to 600 BP
Components C and D—600 BP to 200 BP

The apparently uniform rate of deposition, therefore, suggests that each of these Components was built up over a period of about 200 years.

Although the C14 dates can be used in this way to indicate a relatively constant rate of accumulation in the site, there are some important complicating factors. Of greatest significance is the increase in the density of cultural material in the upper Components. This was noted during excavation as a greater proportion of shell to sand matrix, and is confirmed by analysis of the shell counts in the lower deposits (see below).

A factor which mitigates the increase in shell density, but which cannot easily be measured, is the degree of compression of the deposits brought about by the initial impact, and subsequent pressure, of the massive blocks of roof-fall. A general impression of the force of this impact can be gained from the depressions seen clearly in the sections, particularly in Unit 106 (Figs 4, 5). The midden would have been higher (i.e. more loosely, less densely, structured) before the rock fall, which has compressed the deposits, reducing their volume, and so increasing the apparent density of cultural material. It is, nevertheless, clear that in the upper Components the in-

TABLE 3
FLINT CORES

Unit	Removal	Weight grams
30	04	150.7
30	05	33.4
30	12	32.0
50	15	16.6
50	15	17.7
106	10	35.2
106	12	125.4
Mean		58.7

crease in the relative quantity of shell is indicative of change in the nature of deposition. The greater proportion of sand relative to shell in the lower Components can be ascribed, in part, to the different catchment afforded to wind-blown sand by the jagged rocky base of the site, but may have been due to less intensive occupation—or usage—of the site, as suggested by the analysis.

Although it is impossible to assess, it may well be that the primary focus of occupation at the site in the earlier periods was away from the preserved (i.e. excavated) sections, so that the change in the observed pattern of accumulation was due not to any overall change in site usage, but to a shift of the focus of discard within the site as deposits built up.

While the greater density of shell in the upper Components could be ascribed to some internal change within the site, the fact that the same pattern is repeated in both stone and bone may support an interpretation of a general increase in the intensity of site usage. This problem is examined in greater detail below.

AREA II

One square metre was excavated on the small flat area near the waterfall above the main site.

A maximum of 50 cm of deposit was excavated, with rock appearing from 10 cm below the surface. An upper deposit of coarser dark sand about 5-7 cm thick overlay more clayey deposits.

A few pieces of stone were recovered, but no shell or bone. It is likely that any substantial cultural deposits that may once have been in this area have been eroded off the small platform and down the cliff into the sea.

ANALYSIS

THE DATA

All excavated material was analysed. As noted above, all the deposit from Unit 106 was retained for analysis under laboratory conditions. The bulk of the non-soil deposit consisted of shellfish remains, though stone and bone artefacts and animal bone refuse were also recovered. In analysing the debris we employ a method of density compensation which allows objective comparison of the four components. We deal firstly with the stone and bone artefacts in an attempt to define the

TABLE 4
FLINT—COMPARISON OF MOONLIGHT HEAD AND SEAL POINT

	Flakes	Fragment/ Core Fragment
Moonlight Head	22.9% (55)	66.3% (159)
Seal Point	85.5% (3592)	4.3% (181)
	(From Lourandos 1980: 253)	

technology of those who occupied Moonlight Head Rockshelter from time to time. This is followed by the shellfish analysis in which a diversity measure is developed for comparing collection strategies. Analysis of the other fauna completes our study of exploitation patterns, more fully developed below.

Density Compensation for Data Analysis

While it is legitimate to compare the various layers in a site in terms of the proportions that each category of material contributes to each deposit, considerable problems arise if the differences in absolute quantity are to be studied. A major problem arises when the excavated volumes of layers within the site are different, as is the case with MLH (see Table 1), and also if comparisons are to be made between sites. It is clearly not appropriate to compare the absolute quantities from different excavated volumes.

The basic method of compensation for different excavated volumes is to divide the quantity of the items under study by the volume of the deposit. This gives a standard figure for the density, or concentration. Bowdler (1979: 408), for example, uses this method for comparing density of fish at Cave Bay Cave and Rocky

TABLE 5
FLINT UTILISED PIECES

Unit	Removal	Weight grams	Cortex present	Flake = 1 Frag = 0
106	01	2.5	0	1
106	01	23.0	1	0
106	01	2.8	0	0
106	02	1.1	1	0
106	03	3.0	1	0
106	04	67.0	1	1
50	01	23.8	1	0
50	06	13.8	1	0
50	13	11.3	0	0
50	13	29.1	1	0
26	01	4.3	1	1
26	03	22.8	1	0
30	06	3.5	1	0
41	09	3.4	1	1
106	07	1.8	0	0
30	12	19.3	1	0
106	11	17.5	1	0
30	12	14.1	1	0
106	12	11.3	1	0

Cape. However, Vanderwal and Horton (1983) argue that this method is only appropriate when the depositional environment is similar. Thus, even intra-site comparisons may not be valid for a site deposited over several climatic phases, and the situation may be more complex than this.

Hughes and Lampert (1982) suggested positive correlation between the amount of sediment deposited and increased site usage, measured by the number of implements per unit time. This involves the construction of a depth/age curve for each site to show changing rates of sedimentation (Hughes & Djohadze 1980). While use of depth/age curves may avoid some problems associated with varied site densities, the margin for error in radiocarbon dates leaves some uncertainty. For many sites it is not possible to construct a depth/age curve, due to insufficient data. Furthermore, for inter-, or even in some cases intra-site comparisons, the different surface areas excavated must be taken into account in assessing any kind of absolute measure for the quantity of items deposited.

Comparison with other sites is often difficult where site reports do not give clear information, making it necessary to estimate volumes on the basis of section drawings and occasional details given in the text. The volumes of the deposits at MLH have been calculated directly from the level readings taken during excavation.

At MLH the locations of five dated radiocarbon samples suggest a decreasing rate of deposition. Although each Component covers approximately two hundred years, each is of different excavated area and volume. While the density of any material may be computed, interpretation is complicated by the presence of sandstone blocks in some deposits, and a varying amount of beach sand and other sediments.

In an attempt to lessen the bias of these factors, in each Component the density figures for stone artefacts and bone were adjusted in relation to the shell density, with the shell density held as a constant. In practice this was done by selecting Component D as the standard, dividing the shell density for this Component by that for each Component in turn, and multiplying the stone and bone densities by the resultant factor. In this way, change in bone and stone, relative to the shell, can be seen.

Stone Artefacts

The relatively small sample of stone restricted its analysis to the quantification of the use of stone through time and its documentation for comparison with other assemblages. Small unflaked beach pebbles, roof-fall, stone collected from the surface and the MLH II excavation are excluded from the sample. The surface collection is not considered to provide sufficient control to be comparable with the excavated material, nor is it possible to relate the few flakes from MLH II to the time sequence of the main excavation.

The stone was analysed by Unit and individual Removal. Details of the latter provenance are available elsewhere (Zobel 1982: table 6).

Raw Material Types

The stone was first divided into three groups based on raw material. 1, flint includes all the flaked flint, varying in colour from light grey and light brown to almost black. The one unbroken pebble recovered is not included in the analysis. 2, quartz includes all quartz, which is also highly variable in colour. 3, all other worked stone, including sandstone, quartzite and beach pebbles of various colours.

Morphological Types of Flint

1, cores have signs of flake scars and negative bulbs of percussion, and are listed in Table 3. 2, flakes are characterised by one or more of a striking platform, hinge fracture or bulb of percussion. Not all flakes have the striking platform intact as these may either have been further modified after flaking, or disintegrated on impact. 3, fragments includes all pieces of flint which are neither flakes nor cores.

While at first sight the categories used by us may seem to be comparable to those used by Lourandos for the Seal Point assemblage, this is not the case. Lourandos (1980: 244), defined 'flakes' as: 'recognised by the bulb of percussion *and* by their conchoidal appearance' (emphasis added). Table 4 shows a comparison of the percentage frequency and number of 'flake' and 'fragment'/'core fragment' for Seal Point and MLH. Although Lourandos does not distinguish between raw materials, and it is unclear whether the retouched/utilized pieces are also included in these overall morphological categories, the magnitude of the difference indicates a systematic variation in classification criteria. Lourandos (1980: 247) described his 'core fragments' as 'chunky, somewhat like cores themselves'. While our category of 'fragment' includes such items, it also includes a large number of small pieces, some weighing less than 1 gm. None bear evidence of the direct application of force; rather, they appear to be the result of 'shatter flaking' when the core is struck, as only one flake of several produced will show evidence of impact. Experiments with similar material indicate that this is a frequent occurrence (R. L. K. Fullagar pers. comm.).

Utilisation

The flint pieces in each of the three categories were examined for evidence of use. This was detected primarily by the presence of retouch and macroscopic edge fracturing, supplemented by microscopic examination. Table 5 lists the 19 pieces identified as utilised, indicating whether they are flakes or fragments (use was not detected on any of the cores), and whether or not cortex is present.

While one piece (from 106/02) shows evidence of having been used as a drill (R. L. K. Fullagar pers. comm.), a detailed use-wear analysis to determine the type of use was not undertaken for any other tools. Most wear, however, is consistent with woodworking (R. L. K. Fullagar pers. comm.).

The main areas of identifying the utilised pieces are: 1, to determine the proportion of 'used' to 'unused' items. It is not clear that these data are comparable to those from other sites in the same way that morphological types are, for the application of use-wear studies is not uniform. For example, while 13.1% of flint pieces at Glen Aire II are identified as utilised (Fullagar 1982), only 7.9% were identified at MLH. The Glen Aire material has, however, undergone a much more detailed use-wear analysis which may account for the greater proportion of used pieces recognised at that site. 2, to discover criteria for selection of tools from the many flakes/fragments. 3, to determine whether or not tools were being manufactured at the site, and if their presence/absence correlates with any other factor.

Discussion

In reporting the Glen Aire excavation Mulvaney (1962) noted the lack of formal tools (after McCarthy 1976). Further research has indicated that this is a widespread phenomenon in recent Victorian prehistory (Coutts 1970, 1981a, 1981b, Coutts *et al.* 1976, Lourandos 1980, Wesson 1981, Fullagar 1982).

Coutts has proposed that the move away from formal tool types may have resulted from the need to conserve inland stone resources, formal tools being more wasteful to manufacture. He suggested this may be due to increasing population, and stone resources coming under the control of smaller social groups. When this trend spread to the coast, where flint was abundant, a 'throw away' technology developed (Coutts 1981b).

No recognised morphological types have been identified among the MLH flint artefacts, nor is there much evidence of secondary working. Only 4 of the 19 utilised pieces are classified as flakes. The shapes are highly variable (see illustrations in Zobel 1982). The weights of the pieces range from 1.1 to 67.0 gm, with a mean of 14.5 gm and a high coefficient of variation (107%), indicating that the weights are highly dispersed about the mean.

It may be argued that pieces were not struck with an aim of producing a specific morphology. The lack of secondary working and the fact that many of the used pieces are fragments suggests that any piece with a suitable edge and convenient shape was selected for use. The general pattern of recent Victorian stone tool manufacture makes the alternative hypothesis that more formal tools were produced but did not find their way into the deposits, unlikely.

Change Through Time

The greatest change through the Components is the

Table 6
Stone Artefacts

UNIT	COMP.	Flint used N	Flint used GM.	Cores N	Cores GM.	Flakes N	Flakes GM.	Fragments N	Fragments GM.	Quartz N	Quartz GM.	Other N	Other GM.
16	C							6	10.7			1	4.0
26	D	2	27.1					3	17.8	1	1.0	1	40.9
26	C					2	14.1	5	7.8	1	29.0	2	63.0
26	B					1	4.1	2	1.6	2	15.0	2	441.0
30	D	1	3.5	2	184.1	12	82.7	34	261.7	9	54.0	4	266.0
30	C	2	33.4	1	33.4	6	41.5	31	93.1	4	10.0	1	592.0
41	D	1	3.4			3	4.3	8	26.6	6	18.7	4	418.4
41	C					1	5.6	8	52.3	2	0.8	2	11.3
50	D	4	78.0			9	48.4	20	109.0	3	4.0	11	616.5
50	C			2	34.3	2	11.3	8	75.0			1	1.0
106	D	6	99.4			8	91.6	18	57.9	2	184.0	2	324.0
106	C	1	1.8	1	35.2	3	12.4	10	39.4				
106	B	2	28.8	1	125.4	8	19.5	5	4.3	3	442.0		
106	A							1	4.0				
S	D	14	211.4	2	184.1	32	350.1	83	473.0	21	257.7	22	1563.8
S	C	3	35.2	4	101.5	14	96.2	68	278.3	7	39.8	7	671.3
S	B	2	28.8	1	125.4	9	23.6	7	5.9	5	457.0	2	441.0
S	A							1	4.0				
Total		19	275.4	7	411.0	55	469.9	159	760.7	33	754.5	31	2671.1

S = All units combined into components
N = Number of items
GM = Weight of grouped items

TABLE 7
STONE DENSITY—BY NUMBER

Component		Flint	Quartz	Other
	D	154.1	24.7	25.4
	C	90.8	7.1	7.1
	B	45.2	11.9	4.8
	A	2.9	0.0	0.0
Mean		73.3	14.6	12.4
S.D.		64.8	9.1	11.3
C.V.		88%	62.3%	90.7%

increase in the relative quantity of stone from the lower Components to the upper (Table 6). For the raw number of pieces this trend is evident in all categories, other than for cores. However, as each Component is of a different excavated volume, these numbers were converted to density measures. The results (Table 7) show that the trend is still clearly evident. Coefficients of variation were calculated to compare the degree of change for each type of raw material, to give some indication of the magnitude of the change. It can be seen that the change in flint and 'other' is similar, while quartz, a minimal element, is slightly more stable. The reason for this is unclear. The quartz pieces are rather large, with an average weight of 22.9 gm compared to 7.9 gm for flint.

Chi-square tests on the frequency of raw materials (Table 8) found in Components B, C and D indicate that no significant differences exist at the $p<0.05$ level. Component A was not included because of inadequate sample size. Further tests between the numbers of flint cores, flakes and fragments (Table 9) show significant differences between Components D and C, and C and B (used and unused pieces are combined). Tests conducted on the proportions of used to unused flint pieces indicate no significant differences (Table 9).

The only difference seen, then, is one involving the ratios of flakes to fragments; this, and our knowledge of the material, leads us to suggest that flaking in the later Components may be less controlled, and that further analysis in similar situations is warranted. It is recognised, however, that the observations may be nothing more than the result of a fortuitous distribution.

TABLE 8
CONTINGENCY TABLE ANALYSIS: RAW MATERIAL BY NUMBER

Component	Flint	Quartz	Other
D	131	21	22
C	89	7	7
	Chi square = 4.90	df = 2	
	p = 0.08		

Component	Flint	Quartz	Other
C	89	7	7
B	19	5	2
	Chi square = 3.92	df = 2	
	p = 0.14		
	Yeats' correction is applied		

TABLE 9
CONTINGENCY TABLE ANALYSIS: FLINT MORPHOLOGY

Component	Cores	Flakes	Fragments
D	2	42	87
C	4	14	71
	Chi square = 8.58	df = 2	
	p = 0.1		
	Yeats' correction is applied		

Component	Cores	Flakes	Fragments
C	4	14	71
B	1	9	9
	Chi square = 7.95	df = 2	
	p = 0.02		
	Yeats' correction is applied		

Component	Used	Unused
D	14	117
C	3	86
	Chi square = 3.02	df = 1
	p = 0.08	
	Yeats' correction is applied	

Component	Used	Unused
C	3	86
B	2	17
	Chi square = 0.5	df = 1
	p = 0.54	
	Yeats' correction is applied	

Summary

The most common stone material throughout the occupation of the site is flint. The only significant change detected is the lower number of fragments in the earlier Components. This may be due to more careful flaking of the raw material, but does not seem to have affected the utilised portion of the assemblage, with the relative frequencies of the utilized pieces remaining fairly low.

Flint pebbles, and pebbles similar to much of the material in the category 'other', may be collected from the small stony beach directly in front of the site (cf. Scott-Virtue 1982). The quartz flakes present in the site come from waterworn pebbles, and although none have been seen on the beach, this may be the source. These raw materials, then, need not have been deliberately brought to the site.

Our view of stone use at the site is of a fairly unchanging general technology. The raw material was probably picked up at the site, broken, and suitable pieces selected for the task immediately in mind.

BONE ARTEFACTS

Two bone points were found. One with clear use

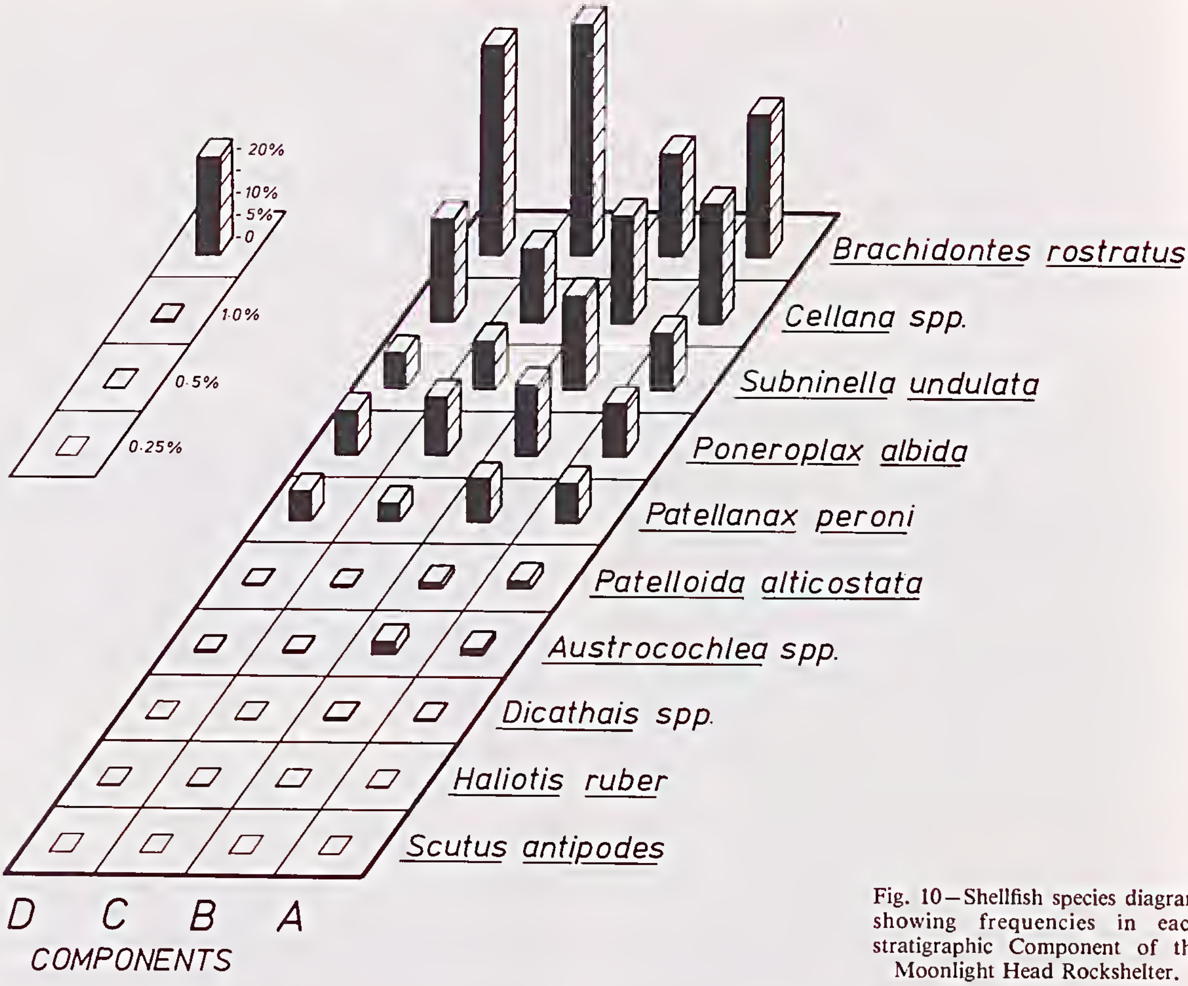

Fig. 10—Shellfish species diagram showing frequencies in each stratigraphic Component of the Moonlight Head Rockshelter.

wear, and breakage due to bending pressure, comes from Component C (Unit 26/11). This is approximately 80 mm long, and is formed on a macropod tibia. The other, which does not show clear evidence of use, may be termed a 'blank' (Fullagar 1982, Pickering 1979) and comes from Component A (Unit 106/02). This point, formed on a similar bone, includes the bone processes, and is approximately 60 mm long. Both would be classified as Unipoints according to Lampert's (1966) terminology, and Simple Unipoints in Pickering's (1979: 50).

Molluscs

Species present in the midden

Ten species are considered to be of dietary importance (Table 10; Fig. 10).

Other species found in the midden were probably not eaten. Several varieties of *Siphonaria* are present in large numbers, but they are very small and would not provide much meat. It is suggested that they were probably collected incidentally, while gathering larger limpets. *Hipponix conicus*, present in very small numbers, is known to live on larger shellfish (Macpherson & Gabriel 1962: 127), and was presumably collected along with their hosts. These species, together with some others found in small quantities, have not been included in the analysis (Zobel 1982).

The species which predominate in the deposits are *B. rostratus*, *Cellana* spp., *S. undulata* and *P. albida*. All 10 species, however, are present in each deposit except the volumetrically small 26/D; all the species are present in the adjoining deposits of the same Component, so their absence in 26/D is probably not significant.

Shellfish Ecology

Shellfish in the MLH midden were rock dwellers and can be found today on the rock platforms adjacent to the site. Factors related to the collection of shellfish are: 1, the intertidal zone each species inhabits; 2, abundance; 3, aggregation.

Following Bennett and Pope (1953: 107; 1960: 188-198) the intertidal fringe is divided into four zones.

supralittoral—above the high water mark.
littoral—within the mean tidal range.

TABLE 10
SHELLFISH RAW MNI PERCENTAGE FREQUENCIES AND CORRELATION COEFFICIENTS

SPECIES LIST

1 = *Haliotis ruber*	6 = *Patellanax peroni*
2 = *Scutus antipodes*	7 = *Patelloida alticostata*
3 = *Brachidontes rostratus*	8 = *Austrocochlea* sp.
4 = *Poneroplax albida*	9 = *Dicathais* sp.
5 = *Cellana* sp.	10 = *Subninella undulata*

PERCENTAGE FREQUENCIES OF MNI PER SPECIES—BY COMPONENTS

	1	2	3	4	5	6	7	8	9	10	
Component D	0.32	0.25	48.47	10.15	23.48	7.15	0.92	1.02	0.65	7.60	n = 44308
C	0.22	0.19	52.18	12.89	17.35	4.18	0.75	1.11	0.44	10.70	n = 31874
B	0.33	0.38	23.02	16.05	24.48	9.71	1.38	2.59	1.17	20.87	n = 9874
A	0.35	0.18	32.33	12.34	27.98	9.25	2.31	1.44	0.95	12.88	n = 10149
Mean	0.31	0.25	39.07	12.86	23.32	7.57	1.34	1.54	0.8	13.01	
S.D.	0.06	0.09	13.77	2.44	4.42	2.52	0.70	0.72	0.32	5.67	
C.V.%	19.0	36.8	35.25	18.9	18.97	33.3	52.19	46.94	40.15	43.56	

infralittoral—between the ranges of the low tide.
sublittoral—below the extreme low water mark.

Haliotis ruber (muttonfish or abalone) are the largest shellfish available on the rocky shore, are generally found between 1 and 10 m below the low water mark, and live in caves and crevices under the rock platform (Shepherd 1973: 222).

Scutus antipodes (duckbill) may be found in similar zones to *H. ruber*, but in relatively small quantities.

Brachidontes rostratus (beaked mussel) live in large, dense clusters. Bennett and Pope (1953: 118) counted as many as 2080 in one square foot. Observations at MLH indicate that large animals are rare, most being less than 25 mm long, and that this species prefers locations sheltered from the main wave action, yet with a constant trickle of water even at low tide.

Poneroplax albida (chiton) is found in the infralittoral zone, just above the low tide mark (MacPherson & Gabriel 1962). These animals are quite common, but are less densely aggregated than *Cellana* spp.

Cellana spp. has not been divided into species. Most are probably *C. tramoserica*, the most common littoral limpet found on the rock platform. The larger *Cellana solida* generally prefers more sheltered locations (King 1973: 145).

Patellanax peroni is much less common than *Cellana* in the mid-lower littoral zone.

Patelloida alticostata is not common, and is also found in the mid-lower littoral zone.

Austrocochlea spp. may be found throughout the littoral zone, but at present is rare at Moonlight Head.

Dicathais spp. is uncommon in the upper to sublittoral zones.

Subninella undulata is a common gastropod in the lower mid to sublittoral zones, and may be found in rock pools on the platform. Surveys conducted by Coutts (1976 *et al.*, appendix 3) indicate that individuals attain substantially greater sizes in the lower zones.

Physical Analysis

Excavated deposits were processed in the field, with the exception of those from Unit 106, reserved for laboratory processing. All material greater than 3 mm was analysed. Shell was sorted into species and then weighed to the nearest gram. It was possible to determine the species of a high proportion of the smaller fragments in the 3 mm fraction—data recorded under laboratory conditions from Unit 106 indicate that between 94% and 97% of the sample, by weight, was identified.

In addition, for Unit 106, three taxa, *Cellana* spp., *Brachidontes rostratus* and *Subninella undulata* were divided into four size classes. These are the major species in the shellfish component of the midden and each present different collecting situations. *B. rostratus* are found in large clusters of many hundreds, *Cellana* spp. are more dispersed and require more 'individual' collection, while most *S. undulata* live beneath the intertidal zone and must be dived for, although smaller animals may live nearer the surface.

Two common methods for quantifying faunal remains are 1, total weight per species, and 2, minimum numbers of individuals (MNI). Although the latter method may produce misleading results as the remains of a single animal may be spread through several stratigraphic samples (Grayson 1979: 203-224), shellfish remains are less susceptible to this problem than vertebrate fauna. Coleman (1966) considers that MNIs provide a better estimate of shellfish meat contribution.

Minimum numbers of individuals have been used in this study, and were determined as follows. Limpets with parts of the shell greater than one half are counted as one. *Brachidontes rostratus* were determined by dividing the total hinge count by two; and *Poneroplax albida* by dividing the total count of plates greater than one half by eight. Experiments in the field indicated that the extra time invested in separating the left and right hinges, or the anterior valve of the chiton, would not yield significantly better results. *Dicathais* spp. and *Austrocochlea* spp. were determined using parts of the shell that had a substantial part of the spire and protoconch intact. While this procedure was carried out for *Subninella undulata*, more accurate figures were obtained from the opercula, which survive better than the rest of the shell, and these have been used in the analysis. *Haliotis ruber* are often highly fragmented, but determinations were made using parts having the central whorl, or the outer lip.

Meat Value Compensation

While meat weight may not be an accurate indicator of nutritional value (Shawcross 1967, Meehan 1977, 1982), it does provide a crude estimate of the food value of each species. The two main methods for calculating this are 1, by using a ratio of shell weight to meat weight (Bailey 1975, Anderson 1981: 111), or meat volume (Coutts *et al.* 1976: table 7); and 2, by estimating the average meat weight per animal for each species (Coleman 1966, Bowdler 1979: 216f, Luebbers 1978: 250, Vanderwal & Horton 1983). We use a variation of the first method. Rather than using actual meat weights the MNIs for each species are multiplied by the following weighting factor. The factors are: *Subninella undulata*—2.7; *Haliotis ruber*—60.0; all other species—1.0. These factors have been derived from experimental work done on modern populations, and further modified after the size analysis of the archaeological samples was completed.

Diversity Measures

Diversity measures were calculated for each Component as a whole, to assess change in the pattern of shellfish use. The value of the measure rises as the proportions that the species contribute become more even. Thus, a (relatively) low measure indicates greater dependence on fewer resources. In this study base 10 logarithms have been used, and as ten species are always present—with the single exception of 26/D—the values for evenness will be identical to those for diversity.

There are two basic components of diversity measures; firstly, the number of species present, the *richness* or variety of the sample; and secondly, the *evenness*, that is the distribution of the individuals among the species (Odum 1971: 49). Several measures have been used by archaeologists, the major ones being 1, the Simpson index (Hardesty 1980), 2, the Shannon index (Yellen 1976, Coutts *et al.* 1976), and in the study of artefacts, 3, a geographer's measure (Whallon 1968, Frankel 1978). Vanderwal and Horton (1983) combine the use of the latter two. (See Zobel 1982, for formulae and further discussion).

In the treatment of data such as ours the Shannon index has been widely used and has thus received more attention from statisticians than the other formulae. Its behaviour is therefore better understood, and has been demonstrated to be evenly distributed for random samples (Odum 1971: 149). Diversity measures also retain information on the structure of the sample that is lost by most other methods. It is possible to study many samples for general trends prior to undertaking a more sensitive analysis.

On raw MNI Component B has the highest diversity (Fig. 11), indicating that resource use is most even, with the trend of increasing dependence on fewer species in the later Components, C and D. Examination of Table 10 indicates that this may be attributed almost entirely to the increasing importance of *B. rostratus*. By comparison, the diversity for the MNIs weighted by meat value shows less variation (Fig. 11), indicating that the more intensively used species do not show an equivalent increase in meat weight contribution. This is because *B. rostratus* does not have a high weight/individual ratio compared to other species.

Correlations Between Species Collected

Table 10 includes the mean, standard deviation, and coefficient of variation for the frequencies of each species through the Components. Of the more common species, *S. undulata* shows the greatest variation, although this is still smaller than that of some of the rarer species. This variability can be further examined by considering the species in terms of the collecting situation they present to the prospective predator, described in section 4.2. To assess the relationship of changes in the quantities of one species with others, correlation coefficients were calculated on MNIs (Zobel 1982, table 4).

B. rostratus has a negative correlation with all the other species. The high negative correlation with *S. undulata* ($r = -0.89$) indicates that this is the major species being replaced. As reflected by the diversity measures, this represents a shift towards collecting a species with less meat per unit, but which is more easily collected.

The three species in the sublittoral zone show little correlation between the trends in their collection. Thus, it seems that there was no consistent attitude towards utilization of this zone; that is, it was species dependent

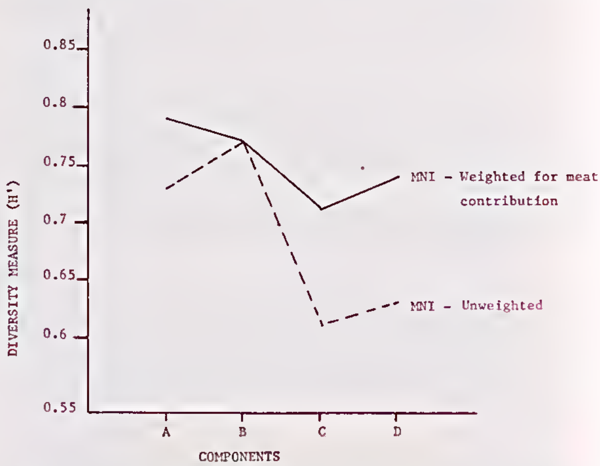

Fig. 11—Diversity (H) for unweighted and weighted minimum numbers of individuals (shellfish) in each Component of the Moonlight Head Rockshelter.

TABLE 11

SHELLFISH—MNI WEIGHTED FOR MEAT CONTRIBUTION PERCENTAGE FREQUENCIES AND CORRELATION COEFFICIENTS

SPECIES LIST

1 = *Haliotis ruber*	6 = *Patellanax peroni*
2 = *Scutus antipodes*	7 = *Patelloida alticostata*
3 = *Brachidontes rostratus*	8 = *Austrocochlea* sp.
4 = *Poneroplax albida*	9 = *Dicathais* sp.
5 = *Cellana* sp.	10 = *Suibninella undulata*

PERCENTAGE FREQUENCIES OF WEIGHTED MNI PER SPECIES—BY COMPONENTS

	1	2	3	4	5	6	7	8	9	10	
Component D	14.60	0.19	36.76	7.70	17.81	5.42	0.70	0.77	0.49	15.56	n = 58410
C	10.09	0.14	40.55	10.02	13.49	3.25	0.58	0.86	0.34	20.67	n = 41013
B	12.92	0.25	14.83	10.34	15.71	6.26	0.89	1.67	0.76	36.31	n = 15325
A	14.90	0.12	22.40	8.64	19.59	6.48	1.61	1.01	0.66	24.35	n = 14501
Mean	13.13	0.18	29.95	9.18	16.49	5.35	0.95	1.08	0.56	24.22	
S.D.	2.20	0.06	13.81	1.23	2.56	1.47	0.46	0.41	0.19	8.83	
C.V.%	16.79	33.16	46.10	13.40	15.54	27.54	48.82	37.79	32.98	36.44	

rather than zone dependent. Potentially, this zone could be the greatest source of shellfish meat. *H. ruber* and *S. undulata* have the largest quantity of meat per individual; the latter, particularly, is plentiful below the low tide mark.

Of the mid-littoral species, *Cellana* spp. shows a high correlation with *P. peroni* ($r = 0.91$) and *P. alticostata* ($r = 0.86$). These three are the only large limpets available, and may be found together. The correlation indicates that these were exploited as a group and little distinction was drawn between them.

In terms of shell numbers weighted for meat value (Table 11), basic relationships show a similar pattern but some differences are worth noting. The negative correlation of *B. rostratus* with *H. ruber* is less, as is the negative correlation of the mussel with *Cellana* spp. This emphasises the fact that it is *B. rostratus* which principally replaces *S. undulata*. The correlations between the sublittoral species, *H. ruber*, *S. antipodes*, and *S. undulata*, are close to zero, providing more evidence that the species within this zone were not exploited as a group. In contrast, the coefficients of correlation between the limpets remain relatively high (see Zobel 1982: table 5).

The coefficient of variation for *H. ruber* is less for meat values than for MNIs, indicating that as one of the important food-contributing shellfish, it is exploited at an even level throughout the occupation of the site. The same is also true for *Cellana* spp., although the other major species (*S. undulata* and *B. rostratus*) continue to show a relatively high variation.

Size Analysis (Fig. 12; Table 12)

B. rostratus, *Cellana* spp., and *S. undulata* were selected for size analysis. This was undertaken only for Unit 106, which spans all four Components and has approximately equal volumes in each Component.

Data on the size frequencies of modern populations were collected from several sources. For *S. undulata*, data are available from near Port Fairy, west of MLH (Coutts *et al.* 1976: appendix 3); a collection was also made at MLH. Data on *Cellana tramoserica* are presented in Coutts (1970a, fig. 25) for several points on the Victorian coast. Data on *B. rostratus* and *Cellana* spp. were collected at MLH.

Brachidontes rostratus

Of the three species, *B. rostratus* has the greatest variation, mainly in the smaller size ranges (Fig. 12). While one must be cautious in correlating a reduction in the size range of a species with the level of predation (Swadling 1976), no clear pattern is evident. The upper Components, C and D, in which this species is the most frequent, do show quite different patterns of size class frequency. This may suggest that, when compared to other species, *B. rostratus* was more intensively collected, though the absolute level of intensity may not have increased.

This species lives in large clusters, and small clusters of larger individuals can be found amongst the mass of smaller individuals. While the age structure has not been assessed in detail, the distribution reflects a situation where few individuals reach a mature age (Fig. 13). The archaeological samples generally show a greater proportion of the slightly larger individuals. The most likely explanation for this seems to be that the species was collected by scraping clusters from the rocks, but that the

TABLE 12

SIZE CLASS RANGES FOR SHELLFISH

	Size Classes 1	2	3	4
Cellana spp.	0-25	25-35	35-45	45 +
	Size class by length in mm			
B. rostratus	0-20	20-30	30-40	40 +
	Size class by length in mm.			
S. undulata	0-2	2-3	3-4	4 +
	Size class by weight of opercula in grams.			

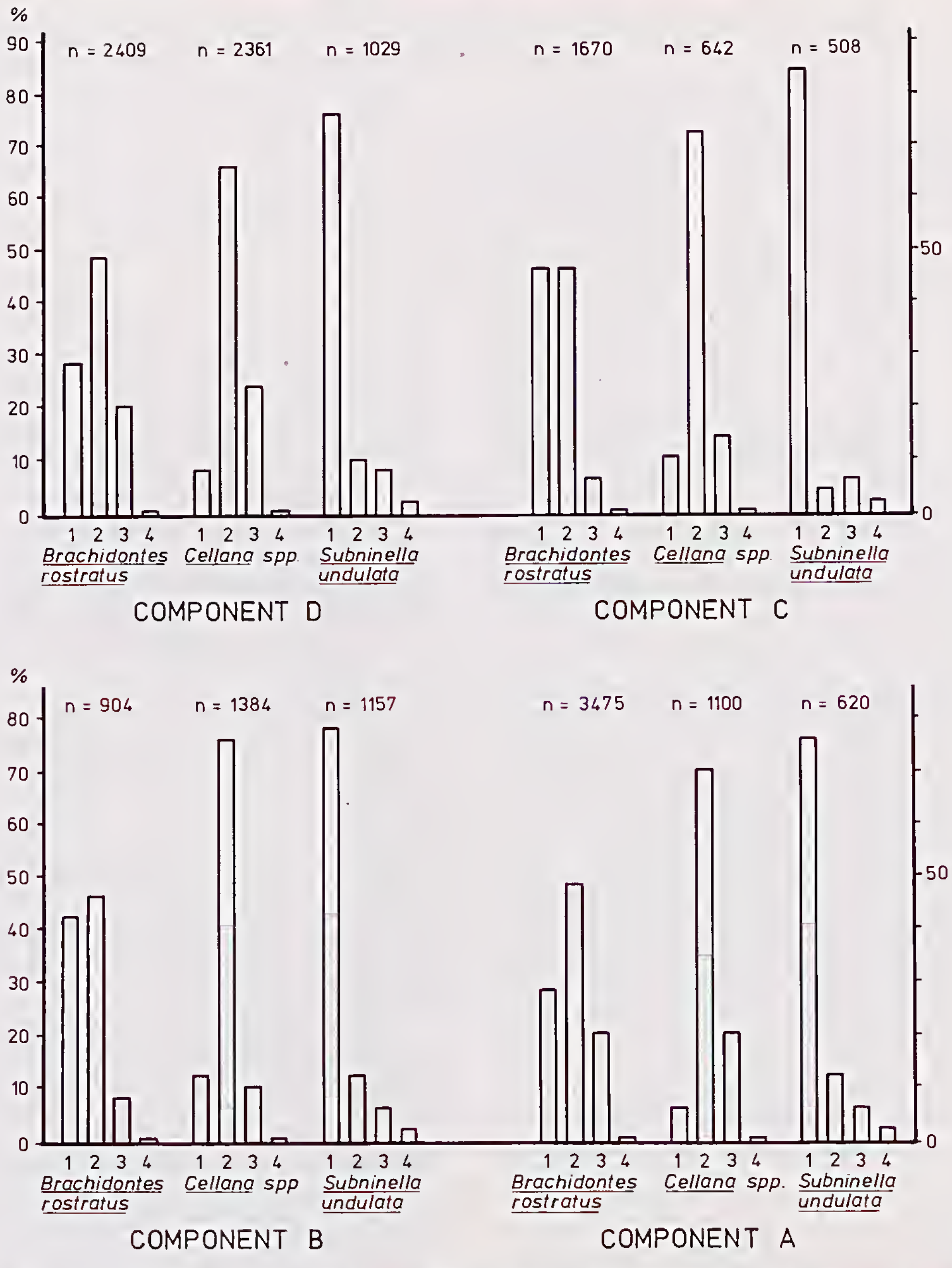

Fig. 12—Frequency bar graphs for shellfish species in each Component of the Moonlight Head Rockshelter.

areas collected from were selected because they included clusters of large shells, and that areas containing mostly small individuals were ignored. There seems, however, to have been no attempt made to select out smaller shells in areas from which collections were made.

Cellana spp.

Unlike *B. rostratus*, limpets require a more individual collection technique, allowing a greater degree of selection. The size frequencies show a similar pattern in all Components, though the percentage in Class 3 fluctuates between 10% and 24%. As with *B. rostratus*, the size changes do not correlate with the change in proportions that the species contribute to the Components, once again perhaps indicating that the absolute intensity of exploitation did not change.

Figure 13 shows the size frequencies for two modern populations of *Cellana*, one from the Yanakie Peninsula

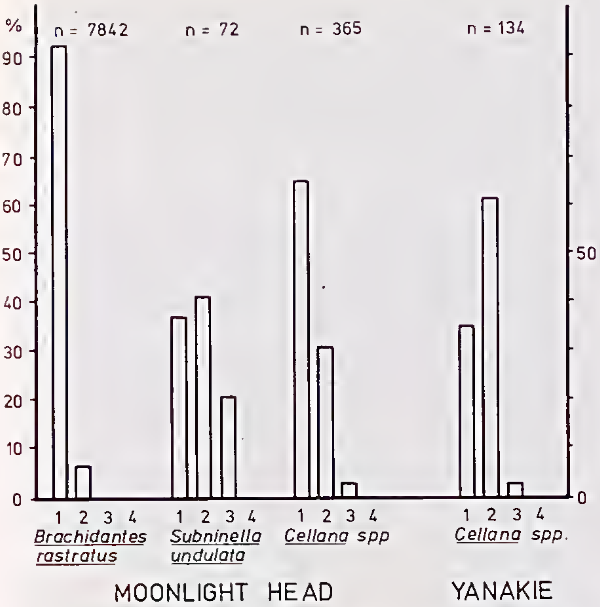

Fig. 13—Frequency bar graphs for shellfish species at the Moonlight Head Rockshelter and Yanakie sites.

(Coutts 1970a: fig. 25), the other from MLH. The Yanakie sample includes a greater number of the larger individuals, probably due to various ecological factors, including the greater intertidal range in that area.

Coutts (1970a: 65) concluded that some size selection towards collecting larger individuals was probably in evidence at the middens he investigated. The same appears to be the case at MLH, with the smaller individuals being ignored. Neither modern sample includes any individual of size Class Four although they are a consistent—if minor—component of the archaeological samples. Observations indicate that the rock platform at MLH supports large individuals in isolation, often quite removed from the areas more densely populated with smaller individuals.

Subninella undulata

Data presented by Coutts *et al.* (1976, appendix 3, fig. 38) indicate that smaller individuals are to be found in the shallow rock pools on the platforms, while larger ones are found mainly in deeper rock pools and crevices under the platform, so that smaller ones could be more easily exploited. The modern MLH sample was collected from the deeper regions, indicating that the larger animals are available in the area.

The frequencies for the archaeological sample of this species show the least variation through the Components, with the smaller individuals being dominant throughout. When this trend is compared with that for the modern sample collected at MLH (Fig. 13), it is clear that the larger individuals were either not available, or were not collected. If the larger *Subninella* were present during the past 1000 years in the same quantity as at present then they would have constituted an extensive potential resource. This species is not the major component of the shell sample in the midden and it would seem that deep water stocks were not heavily exploited.

Shellfish Discussion and Summary

There seems to be no clear trend of size range fluctuation correlating with the changing trends of dependence on the different species. Over-exploitation—as evidenced by a reduction in the size ranges—is not likely to be a factor at MLH.

In looking at collecting strategies it is useful to distinguish two collecting zones—above and below the low water mark. In the upper zone the major species are the limpets (*Cellana* spp. and *P. peroni*), and the mussel (*B. rostratus*). The species present in this zone are exploited approximately in the proportions that they are available on the platform: thus the strategy is fine grained.

Exploitation of the subtidal zone, which could supply not only the greatest quantity, but also the most sustained meat yield, is not as extensive as might be expected. Sustained diving efforts were not made to collect the larger *H. ruber* and *S. undulata*.

Anderson (1981) has postulated a model for shellfish collecting strategies in which the collectors are assumed to take account of only the size of the individual animal, regardless of species. His model proposes that initial exploitation of the resource should be fine grained, but become more coarse grained, concentrating on the more abundant species as the larger animals from the other species are thinned out. While the diversity measures indicate a trend towards a coarse grained strategy of increasing reliance on *B. rostratus*, Anderson's model does not seem to adequately explain this, as another abundant species, *S. undulata*, was ignored. The exploitation pattern of the upper zone remains fairly fine grained.

This leads to the conclusion that shellfish were not a major contributor to the diet. Little evidence for a change in the intensity of exploitation of molluscs has been found. Furthermore, the decrease in exploitation of the sublittoral zone indicates that in a changing resource use schedule, shellfish were replaced by some more favoured resource.

Other Fauna

Quantification

The bone in the site is considered to be the result of

Table 13
Vertebrate Fauna MNI

		Component			
	Total	D	C	B	A
Labrid fish	13	4	7	1	1
Crayfish	10	6	1	1	2
Possum	7	4	3	—	—
Wallaby	2	2	—	—	—
Seal	2	—	1	—	1
Total	34	16	12	2	3

TABLE 14
BONE WEIGHT—WITHOUT SEAL

		Unit 16	26	30	41	50	106	Total
COMPONENT	D		3.5	151.2	36.2	61.6	44.4	296.9
	C	10.6	26.8	62-9	10.1	9.7	14.5	134.9
	B	1.3	15.5		0.2		15.7	32.7
	A		2.7				23.0	25.7
								490.2
	BONE WEIGHT—WITH SEAL IN GRAMS							
	D		3.5	152.2	36.2	61.6	44.4	296.9
	C	10.6	30.6	94.4	10.1	86.6	14.5	246.6
	B	1.3	15.5		0.2		15.7	32.7
	A		13.6				23.0	36.6
								612.8

human discard as there is no evidence of burrows or any other use of the site by animals, while in more recent times the midden was sealed by rock fall.

Quantification is by MNIs and by weight. MNIs are determined using principally the mandible, maxilla and teeth. Fish were analysed on the dentary and pharyngeal bones, and seal using vertebrae as this was all that was found in Component C, and a maxilla in Component A (Table 13). The bone, sorted only into seal/non-seal, was also weighed. This separation was made so that the greater mass of the seal bone would not mask changes among smaller species.

The amount of bone increases markedly from the lower level to the top of the site (Table 14), whether measured by MNI or by weight. Very high values of correlation between MNI and weight, including ($r=0.97$) and excluding ($r=0.99$) seal (Zobel 1982, table 16) indicate that both methods are providing much the same information. Unfortunately the number of cases is too small for tests of statistical significance to be applied.

In order to examine the relative change of the amount of bone through time the raw bone weights were converted into standard density measures by dividing by the volume of the appropriate deposit. Although somewhat reduced, the density measures still show a strong directional trend toward more bone in the upper deposits (see Zobel 1982, table 17). It is unlikely that any differences are due to varied preservation, as the pH readings at MLH are fairly constant, varying only between 8 and 9. Furthermore, the presence of large quantities of shell leads to more rapid mitigation of the chemical weathering effects of percolating water. The MLH deposit would probably have remained moist at all times due to its close proximity to the sea.

Analysis

The most common animal found at the site is parrot fish (Labridae), followed by crayfish (*Jasus* sp.). Both are found through all Components, but are more common in the upper ones (Table 13). Land mammals, which were not determined in the lower Components, become increasingly important in the upper part of the site.

Fish and Crayfish

Parrot fish are most commonly found in rocky shore environments, and are generally considered the easiest fish to catch (Leach & Anderson 1979: 9, Bowdler & Lourandos 1982: 129, Jones 1978: 27, 32), although Leach and Anderson (1979: 4) consider them easier to catch in nets than with hooks. The most commonly surviving cranial bone of these fish at MLH is the inferior pharyngeal (which has also been noted in New Zealand sites, Leach and Anderson 1979: 6). The maximum length of these was measured on all but one, which was too fragmented (Fig. 14). If this distribution is compared to that of Seal Point (Bowdler & Lourandos 1982, fig. 3), it can be seen that the MLH sample shows a similar peak at around 20-25 mm, but has a narrower range. On the basis of their size analysis Bowdler and Lourandos (1982: 130) argued for fishing with fixed gill nets. They further argued for a correlation between bone point and fish frequencies (1982: 124). The presence of two bone points at MLH cannot be taken as evidence for either extensive manufacture or use.

The presence of parrot fish and crayfish through all Components, in conjunction with the shellfish, indicates a continuing use of the rock platform environment as an important source of food.

Seals

Two seals have been identified at MLH, one in Component A where a maxilla is present, the other in Component C, represented by several vertebrae. A seal may provide a considerable quantity of meat, but in terms of the overall use of the site, these individuals represent only two visits during one thousand years. The nearest seal colonies today are further west along the coast, on the offshore islands near Port Fairy (Ride 1970: 198). Though studies have indicated that seals are often washed up along the Victorian coast (Warneke 1975),

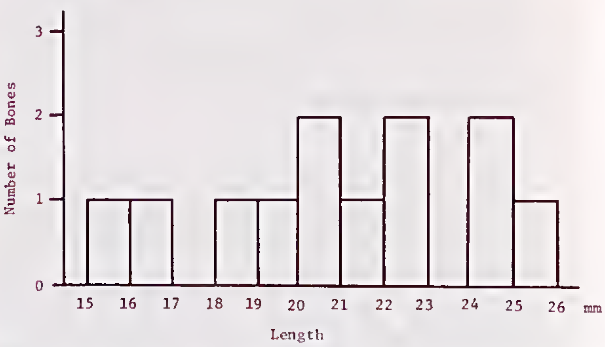

Fig. 14—Lengths of animal bones at the Moonlight Head Rockshelter.

their presence at MLH probably indicates opportunistic finds when people were in the area at the right moment.

Land Mammals

By far the most common land mammal represented at the site is the Common Ringtail Possum (*Psuedocheirus peregrinus*). This species is at present common and widespread in the Otway Ranges, preferring the coastal messmate forest environment (V.L.C.C. 1976: 292) or nesting in coastal tea-tree scrub (Ride 1970: 72).

Two wallaby-sized animals are present in Component D. The maxillae by which they were identified are fragmented, making positive identification difficult. With the exception of the bone point, remains of the larger macropods appear to be absent. Strictly adhering to methods of analysis developed in greater detail by Zobel (1982), we may note that, in terms of MNIs, land mammals are absent in the lower two Components. There seems to be no reason to believe that any major vegetational changes have taken place in the Otway region during the last thousand years (Head & Stuart 1980: 67). As it seems unlikely that the availability of land mammals has changed during the occupation of the site, a change in the nature of use of the site may be indicated.

Summary

While numbers of individuals are too small for statistical methods to be applied, two main trends in the non-molluscan faunal remains may be seen.

The quantity of bone by weight, compensated for density, shows a clear increase through time at the site, both in absolute terms and relative to the shell density. This is accounted for by an increase in fish, crayfish, and land mammals in the upper two Components.

Lourandos suggested that land mammals represented at Seal Point were isolated finds (1980: 291), in contrast to the marine resources, where the parrot fish, crays, and some shellfish were found in the same ecological zone. In her interpretation of the Stockyard site, O'Connor (1980: 111) suggested that small land animals may have been collected by women on their way to the site. This may well be the case at MLH, as any route to the site passes through habitats suitable for the species present. The increase in these animals may still, however, indicate some decision to pay more attention to these resources during the latter period of occupation.

CONCLUSIONS

Site Formation

The radiocarbon dates show a clear pattern in the depth/age diagrams (Figs 8, 9) with the possibility of a slightly slower rate of deposition in the upper half of the site. However, as the figures for shell density show (Table 15), Component D has nearly twice the density of the other Components. This is probably the result of compression of the upper layers by the extensive roof-fall. The rate of deposition can therefore be regarded as relatively constant.

To compensate for the effect of this compacting, and to examine the change in stone and bone relative to each other, and to shell, the density measures for the former two were adjusted to a constant shell density. As can be seen in Table 15, the weight of bone increases upward through the Components. The stone artefact quantities also increase, though this is not so marked in the upper three Components.

Resource-use

Change in resource-use may be explained in a variety of ways, including cultural and environmental explanations. A slight shift away from a marine-oriented economy may be seen at MLH, with a trend towards a more general exploitation of the area with a greater variety of resources being exploited. Different strategies in resource collection are in evidence, indicating a change in the logistical structure of settlement and exploitation.

While more of the time spent at the site was put into fishing for labrids in the later periods, less time was invested in shellfishing by concentrating on the more easily collected mussel (*B. rostratus*).

This increase in the use of land mammals is also seen at Seal Point, with the same species—the Common Ringtailed Possum—being by far the most frequently represented animal. Labrids are similarly the dominant fish species (Lourandos 1980). In his most recent discussion of Seal Point, Lourandos proposes that the increase of land fauna use reflects an increased availability of these resources (Bowdler & Lourandos 1982: 129). However, as no major vegetational changes occurred during the period of occupation of either site, no major fluctuations of resource availability need be assumed. A degree of circularity of argument is implied if simple frequencies of animals in a site are taken as an indicator of

Table 15
Density of Bone, Stone and Shell

	Shell MNI		Stone No.		Bone no seal grams		Bone with seal grams	
	X	Y	X	Y	X	Y	X	Y
Component D	52121.1	1	207.1	207.1	349.3	349.3	349.3	349.3
Component C	32524.5	1	106.1	170.0	134.4	215.4	251.6	403.2
Component B	23509.5	1	61.9	137.2	77.9	172.7	77.9	172.7
Component A	28997.1	1	20.0	35.9	73.4	131.2	104.6	188.0

X = Raw density measure
Y = Density measure adjusted by shell density.

availability. Unfortunately, the sample at MLH is too small to allow any more sophisticated analyses of the fauna available, as in order to make some assessment of the resource abundance, some assessment of the sex/age structure of the population must be made.

At Bass Point, in N.S.W. near Sydney, Bowdler found a pattern of shellfish change similar to that seen at Moonlight Head, with a trend away from exploiting the sublittoral gastropod *Ninella torquata*, and towards greater use of the mussel *Mytilus edulis* (1976: 255). As at Moonlight Head, this results in less meat per animal collected. The change observed in the Bass Point fish remains seems to be one of change in emphasis between species, rather than a trend toward or away from a concentration on fewer species; the diversity measures (H') are 0.66 and 0.67 for the upper and lower middens respectively (data from Bowdler 1976, table 1). Bowdler interpreted this change in exploitation as due to a historical change in technology—the introduction of fish-hooks—affecting the food-providing role of women. Similarly, Smith (1977), in relation to changing technology, discusses the possibilities for different structures of the groups exploiting Devon Downs.

As neither of these environmental or historical/cultural models seems entirely adequate at Moonlight Head, some discussion of other factors relating to resource use may be of value.

Resource 'Pull'

Both Wilmsen (1973) and Jochim (1976: chapter four) have given theoretical consideration to the effect of the density, size, and mobility of resources on the optimal settlement patterns for effective exploitation. Based upon a theoretical model, in which 'least cost' in terms of time and energy is postulated, Jochim proposes that site locations will be closest to less mobile, more dense and less clustered resources (1976: 60).

Clearly, shellfish fulfill all of these criteria, and should, according to this model, have considerable influence on site location. Shellfish, furthermore, are a reliable resource. If the culling rate is not so high as to deplete the reserves—and no evidence for this was found at MLH—then a trip to any rock platform will supply a meal.

During the early period at the site, shellfish provided just such a reliable, but short-term, resource. During the later period, the inclusion of land mammals and increased reliance on fish provided greater variety of food.

Site Use

The resource-use at MLH can best be understood in a wider context of other Victorian sites.

Seal Point, located about 45 km east along the coast from MLH, has been interpreted as a base camp (Lourandos 1980, Bowdler & Lourandos 1982). The most striking difference from MLH is the much greater quantity of stone and mammal bone. As noted above, the same species predominate, with the exception of seal which is much more important at Seal Point. The area of the pits analysed—F, G, I, and J—is 4 m, compared to 3.75 m at MLH; estimates of the volume of these pits from the sections and data given in the text (Lourandos 1980), indicate a volume of about 3.25 m^3, compared to 2.6 at MLH. Both sides were occupied over the last thousand years. The greater density of stone and bone at Seal Point indicates greater use of the site. The interpretation of this site as a 'base camp' is made on several grounds, including the presence of depressions thought to be hut pits.

In contrast to the situation at MLH, *S. undulata* is the dominant shellfish species (Bowdler & Lourandos 1982). An explanation for this may lie in the apparent longer occupations of Seal Point. The species on the littoral zone of the rock platform would not survive such sustained exploitation as the extensive sublittoral supply of *S. undulata.*

Comparative information on some other Victorian coastal sites may be found in Coutts *et al.* (1976). The Gippsland site of Clinton Rocks, which has been termed a 'temporary' camp (Coutts 1981a: 76) is dominated in all layers by *B. rostratus*; no other shell species contributes more than 10% in any layer. The evenness measure is low, 0.32, indicating a much greater dependence on this single resource than is evident at most other sites. Two middens excavated in the Port Fairy area show different distributions. At the Reamur Rocks site *S. undulata* predominate, the evenness index in 0.63, compared to 0.77 at The Craigs, indicating a more even use of the species at the latter site. (The evenness indices are recalculated from data provided by Coutts *et al.* 1976). It is clear that change in the use of the various shellfish species, both between and within sites, is due not only to the shellfish habitats adjacent to the site, but also the way the site fits into the resource use cycle.

Coutts (1981a), distinguishing between temporary camps and base camps, suggested that the latter may be expected to contain evidence of stone tool manufacture, and a greater quantity of bone remains than the former. The distinction may not, however, be so clear. At many points along the west Victorian coast, apparently *in situ* thin shell lenses, often only a few centimetres thick, are being exposed by eroding dunes. No stratigraphic features are commonly found in these sites (Coutts *et al.* 1976: 9-10). They are presumably the result of less specific site placement considerations. On morphological grounds, deep, stratified sites such as MLH and Seal Point are quite different.

No clear change in the stone artefacts at MLH has been found. Although a detailed use-wear analysis was not undertaken, Richard Fullagar has suggested that some of the wear patterns are consistent with woodworking (pers. comm.). We may postulate that this is due to maintenance of the organic parts of an extractive tool-kit. At the very least, we can say that stone tool manufacture and use is in evidence at MLH, although perhaps not to such a great extent as at Aire Shelter II (Fullagar 1982) or Seal Point.

It may be suggested that the distinction between base camp and temporary camp is not as clear as has been thought. Considerable variability exists in the morphology and contents of Victorian coastal sites, and this variability can be seen as a continuum in the range of site type from residential base camps, such as Seal Point, to the thin shell lenses, possibly the result of a single visit. In behavioural terms certain types of sites may be suggested. One type would be the 'dinnertime' camp defined by Meehan (1982) for the Anbarra. She notes that these sites may either have been used once, or visited many times. The type is defined on the contents of the site, reflecting only the collecting and cooking of shellfish.

At the other extreme, a 'base camp' should reflect a wider range of tasks, including manufacture of the extractive tool-kit, and exploitation of a wider range of foods used in subsistence. Aire Shelter II may be placed midway along this continuum. While this site shows a wide range of activities, each occupation may not have been as lengthy as in a base camp, such as Seal Point. Within this broader behavioural model of site usage we may suggest that the concentrated deep midden at MLH probably assumed its form as a result of the particular shape of the shelter acting as a catchment for debris, and providing a focus for activity over successive occupations not found at open sites, rather than directly reflecting intensive use of the site.

We can then see the logistics of the subsistence strategies as being organised on several levels. The change in the use of Moonlight Head may reflect a slight shift in this logistical pattern, moving away from a less intensively used dinnertime camp, and towards a camp involving a wider range of activities and foraging strategies.

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